



*Veridian Engineering*

Flight Research Group

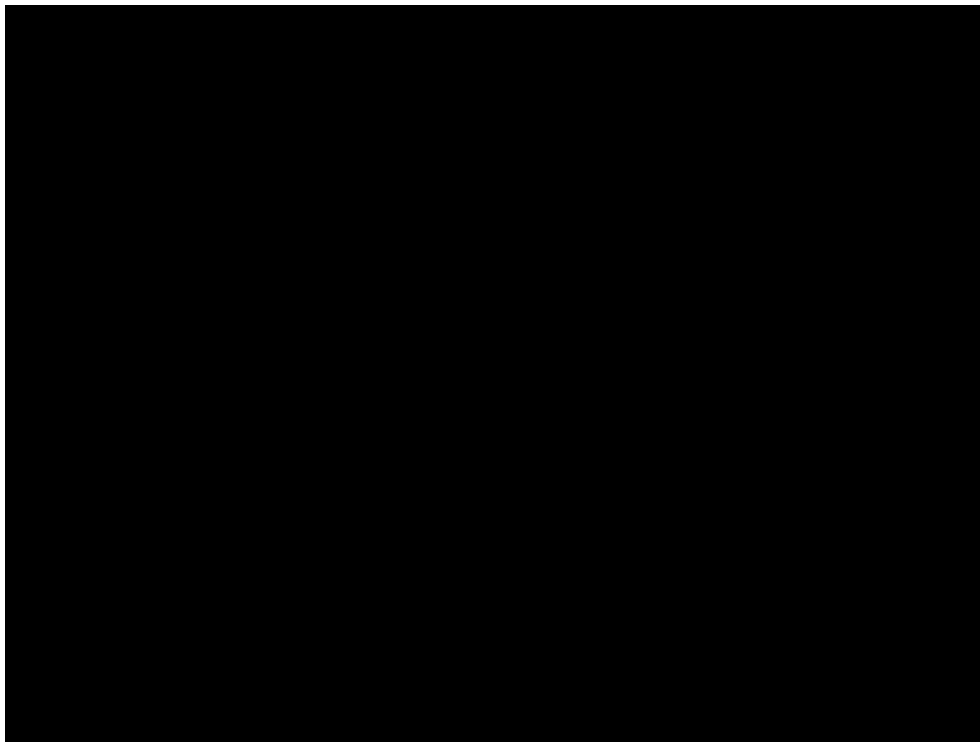
# Spatial Disorientation and Situational Awareness

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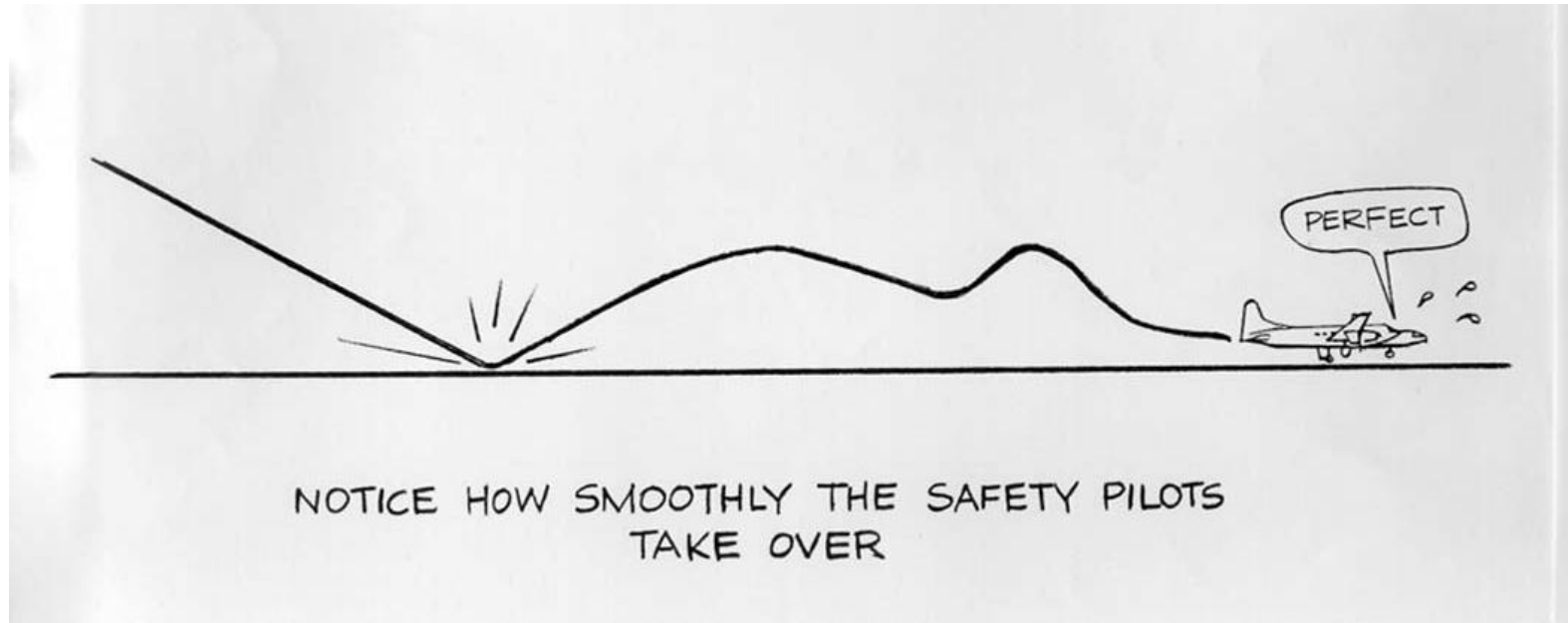
# Agenda

- ✍ Spatial Disorientation (SD) Definition
- ✍ Situational Awareness (SA) Definition
- ✍ Knowledge Required to Maintain Spatial Orientation (SO)



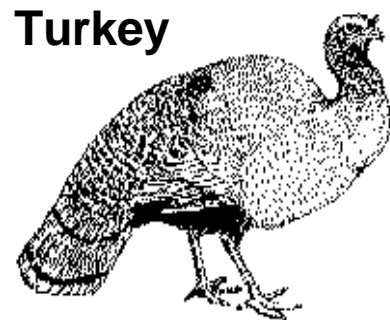
# What is SD?

- ✎ Spatial Disorientation – “aviator fails to appreciate correctly the attitude, position, and motion of his [or her] aircraft with respect to some external reference such as the earth’s surface” (Benson, 1973, p. 944)

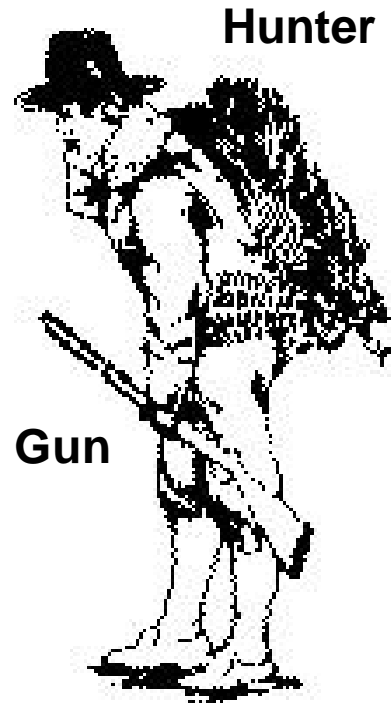


# What is SA?

🔍 The perception of elements in the environment:



**Turkey**

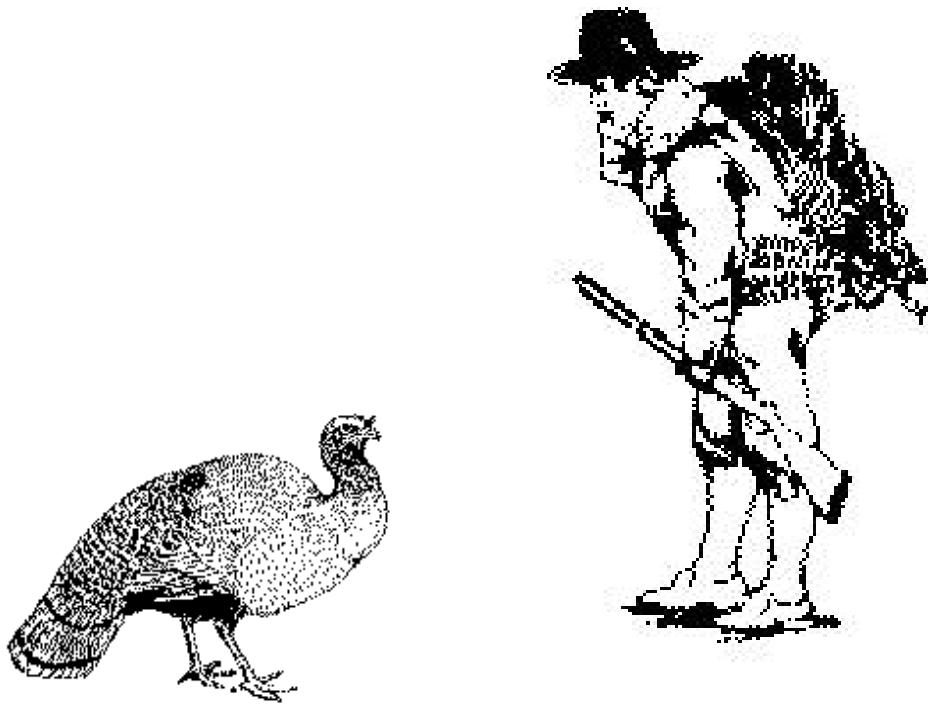


**Hunter**

**Gun**

# What is SA (cont.)?

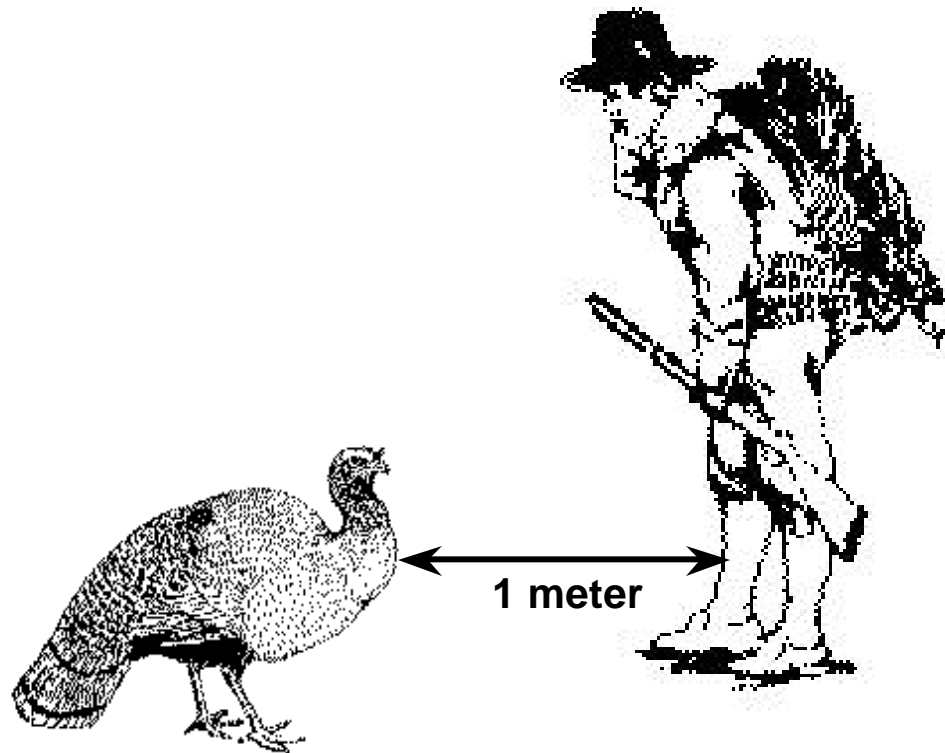
✎ Within a volume of time:



**Two days before Thanksgiving**

# What is SA (cont.)?

✎ And space,



# What is SA (cont.)?

✍ The comprehension of their meaning,



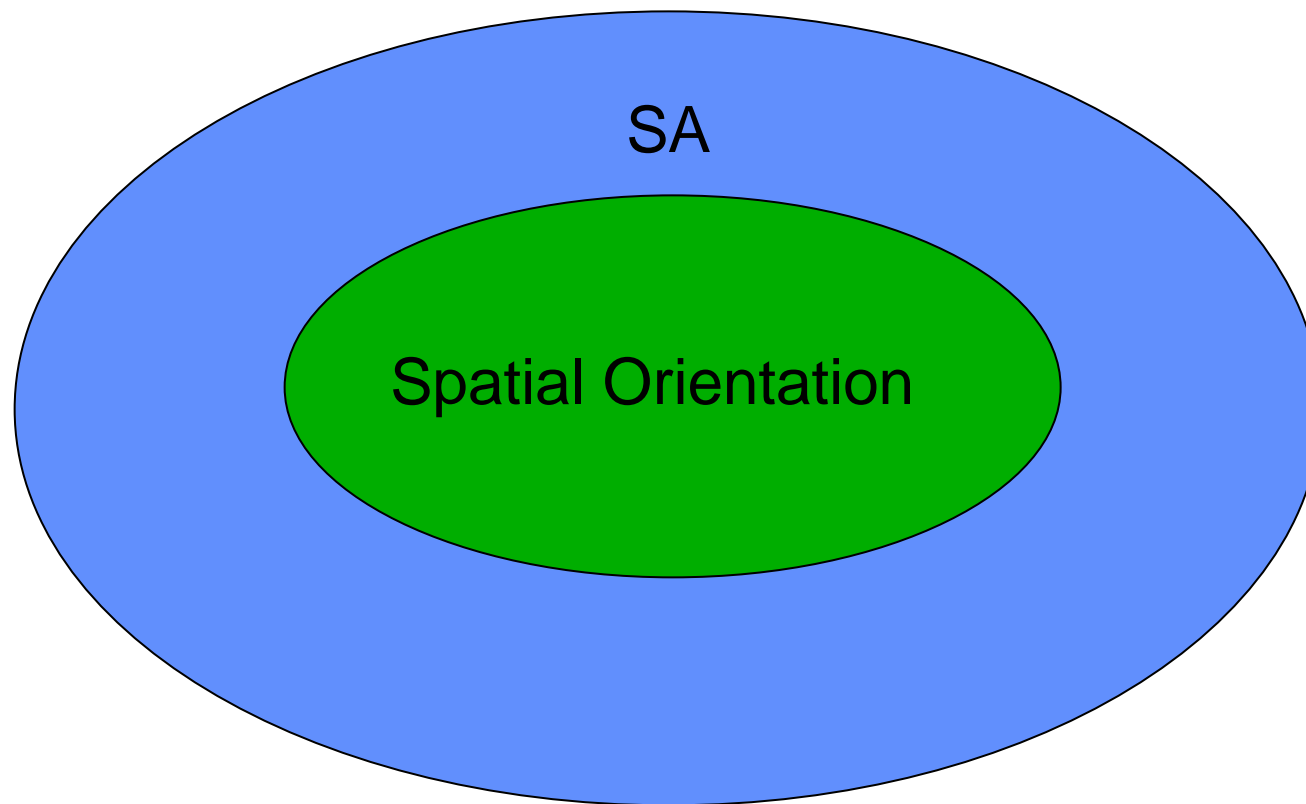
# What is SA (cont.)?

- ✍ And projection of their status in the near future





# Comparison of SD and SA



# SO and SA Requirements in Aviation

## ✎ SO:

- Geographical SA
- Spatial/temporal SA

## ✎ Additional SA:

- System SA
- Environmental SA
- Tactical SA

From Endsley, 1997, pp. 3-4



# SO Requirements in Aviation

- ✎ Spatial/temporal SA - Attitude, altitude, heading, velocity, vertical velocity, G loading, flight path; deviation from flight plan and clearances; aircraft capabilities; projected flight path; projected landing time

Endsley, 1997, pp. 3-4



## SO Requirements in Aviation (cont.)

- ✎ Geographical SA - location of own aircraft, other aircraft, terrain features, airports, cities, waypoints and navigation fixes; position relative to designated features; runway and taxiway assignments; path to desired locations; climb/descent points

Endsley, 1997, pp. 3-4



# SA Requirements in Aviation

- ✎ System SA - System status, functioning and settings; settings of radio, altimeter and transponder equipment; ATC communications present; deviations from correct settings; flight modes and automation entries and settings; impact of malfunctions/system degrades and settings on system performance and flight safety; fuel, time and distance available on fuel

Endsley, 1997, pp. 3-4



# SA Requirements in Aviation (cont.)

- ✎ Environmental SA - weather formations (area and altitudes affected and movement); temperature, icing, ceilings, clouds, fog, sun, visibility, turbulence, winds, microbursts; IFR vs. VFR conditions; areas and altitudes to avoid; flight safety; projected weather conditions

Endsley, 1997, pp. 3-4



Jillian Touring



# SA Requirements in Aviation (cont.)

- ✎ Tactical SA - identification, tactical status, type, capabilities, location and flight dynamics of other aircraft; own capabilities in relation to other aircraft; aircraft detections, launch capabilities and targeting; threat prioritization, imminence and assignments; current and projected threat intentions, tactics, firing and maneuvering; mission timing and status

Endsley, 1997, p. 4



# SA Requires Knowledge

- ✎ SA Requires Knowledge:
  - Internal states of the humans and systems
  - External states of the humans and systems
  - System and environment relationship
  - Environment - temperature, position, terrain

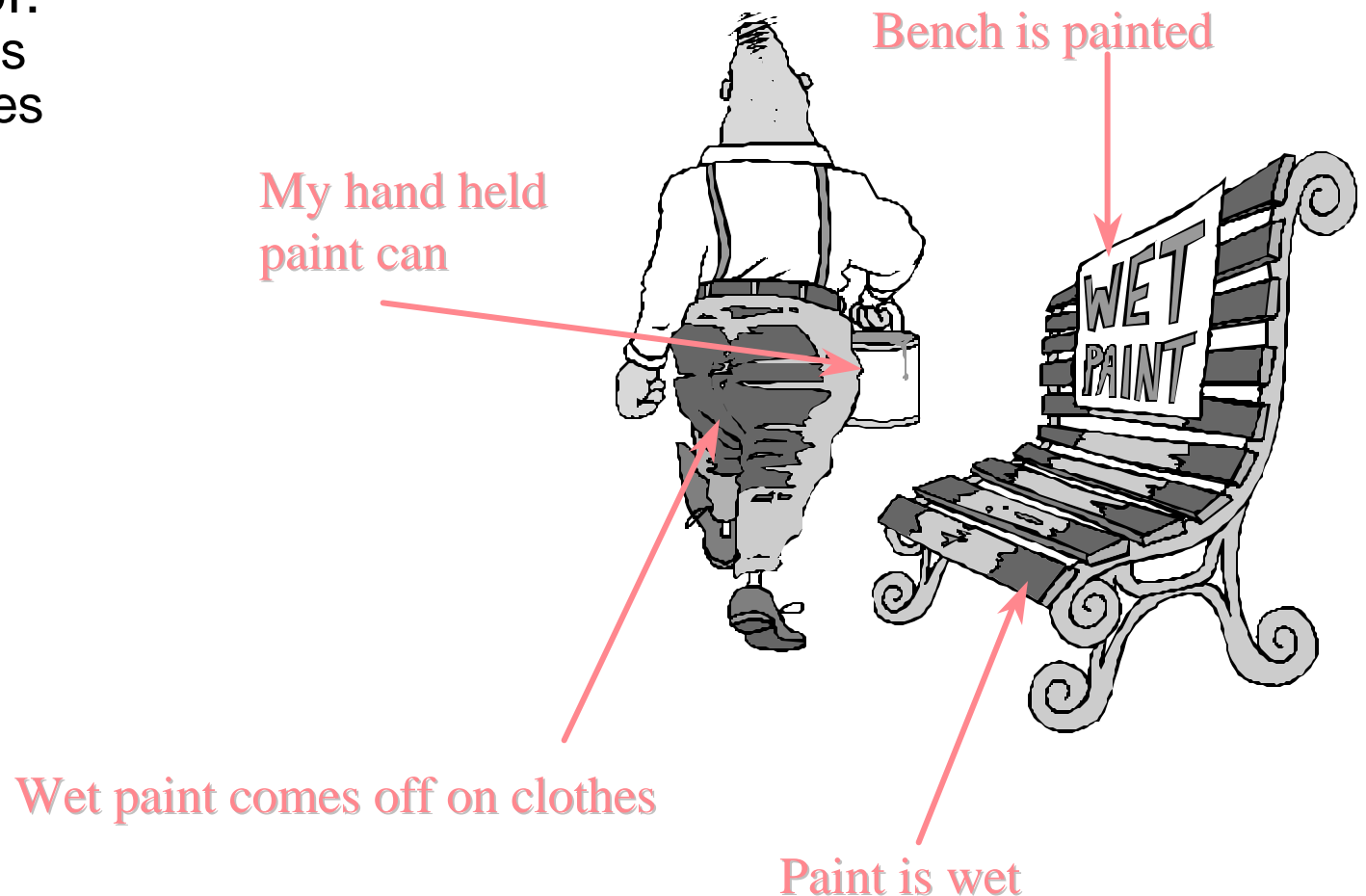




# Components of SA Definitions a.k.a Human-System-Environment Relationships

## ✍ Knowledge of:

- Internal states
- External states
- System
- Environment



# SO and SA Requires Knowledge

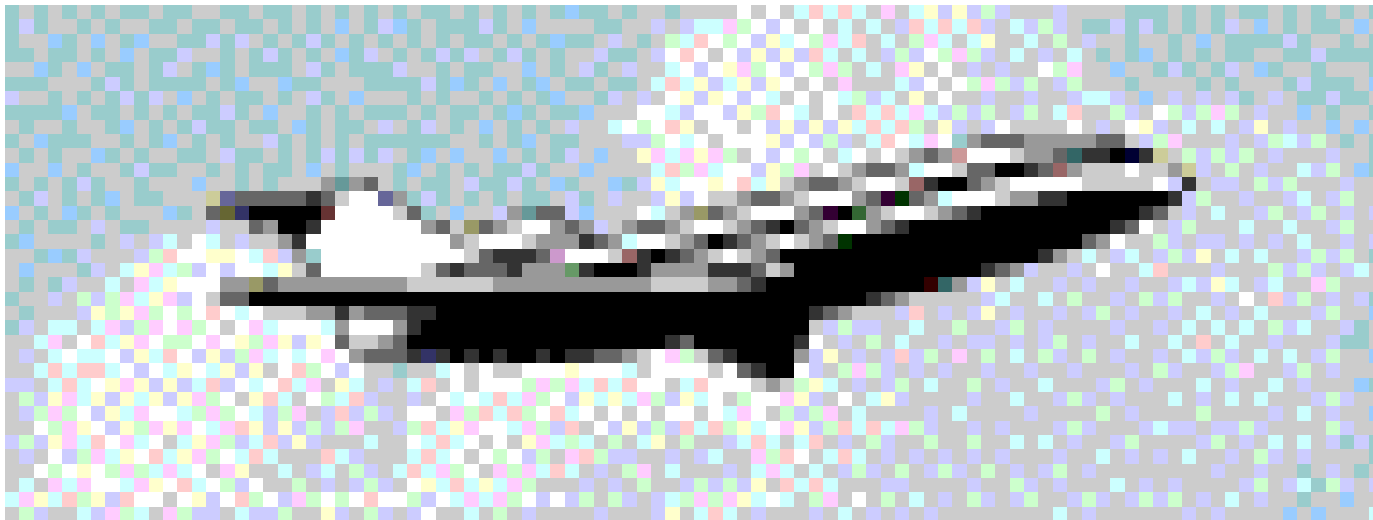
- ✎ Knowledge of:
  - Internal states
  - External states
  - System
  - Environment



# SO Knowledge of Internal States

## ✎ SD phenomena

- Break out - “Symptoms characterized by an altered awareness of their orientation and relationship to the aircraft or the earth when flying at high altitudes or in visual conditions of flight comparable to those experienced at high altitude” (Benson, 1973, p. 945)



# Break Off

- ✎ **Break off** – a feeling of instability, though less frequently there is a heightened awareness of aircraft motion with an exaggerated perception of the attitude or change of attitude of the aircraft (p. 950)
- ✎ **Break off without false perception of aircraft orientation** - Pilot felt “overcome by a ‘feeling of unreality’ and remoteness from the aircraft” (p. 945)
- ✎ **Break off with instability** – he was suddenly overcome by a feeling of isolation and of being ‘out of touch’ with the aircraft (p. 945)
- ✎ **Break off with quantitative disorientation** – he had a feeling of being ‘out of touch’ with the aircraft. This sensation of detachment was accompanied by one described as ‘dizziness’ (p. 946)
- ✎ **Break off with qualitative disorientation** – begin to feel out of touch with the aircraft and uneasy. Concomitantly, there was a sensation that the aircraft was banked 30 – 40° left wing low which at times was associated with a false perception of a slow turn to the left (p. 946)

# SO Knowledge of Internal States (cont.)

- ✎ **Giant Hand** – While in a left-hand climbing turn, he [Dr. P.A.H. King] bent his head down and to the right to find the radio compass audio switch, and he experienced violent vertigo. He said that “upon attempting to level the wings, I experienced extreme control stiffness and found that even using both hands and knees I could not move the control column to the right.... It felt as though a giant hand was thrusting the stick to the left (Lyons and Simpson, 1989, p. 64)



# Giant Hand

- ✎ January 1986 single-seat fighter pilot ejected due to Giant Hand phenomenon
  - Lead in a two-ship
  - Night instrument flight
  - While in right descending turn, he turned his head to the right to check wingman's position
  - Overwhelming sensation of rolling to the left
- ✎ 97 Air Force pilots
  - 15 experienced Giant Hand
    - ✎ Always occurred during night or under instrument conditions
    - ✎ 4 mentioned occurrence during formation flight
    - ✎ 1 pilot had multiple episodes
  - 82 did not
- ✎ Thumb and index recovery technique

# SO Knowledge of Internal States (cont.)

- ✍ Absent focal cues
- ✍ Aerial perspective
- ✍ Black hole
- ✍ Coriolis sensation
- ✍ False horizon
- ✍ False sensation of bank
- ✍ False sensation of height
- ✍ Flying carpet
- ✍ Lean on the sun
- ✍ Leans
- ✍ Lost horizon
- ✍ Sensation of climbing in turn
- ✍ Shape constancy
- ✍ Size constancy
- ✍ Somatogravic illusion
- ✍ Star-ground light conflict
- ✍ Visual autokinesis
- ✍ Whiteout

# Summary

- ✍ SO requires:
  - Spatial/temporal SA
  - Geographical SA
- ✍ SA also requires:
  - System SA
  - Environmental SA
  - Tactical SA



# Any Questions

